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ABSTRACT

Material for this teacher's guide includes: (1) an introduction to the unit; (2) a discussion of the sections of the unit; (3) instructional objectives; (4) suggestions on use of filmstrips, worksheets, reference materials, and activity cards; and (5) an outline of the unit. These materials have been validated as successful, cost-effective, and exportable by the standards and guidelines of the U.S. Office of Education. (RH)

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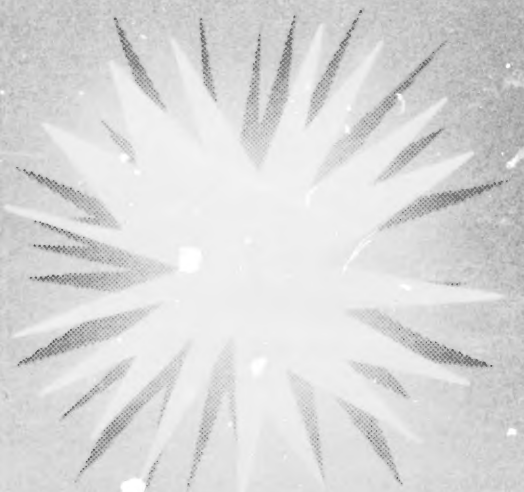
PRIORITY ONE
ENVIRONMENT

THE ENERGY CHALLENGE



PRIORITY ONE
environment

POLLUTION CONTROL EDUCATION CENTER
Township of Union Public Schools
Union, New Jersey

THE ENERGY CHALLENGE

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THE ENERGY CHALLENGE

CONTENTS

INTRODUCTION TO THE UNIT

The Energy Challenge 2

SECTION I

The Energy Consumer 5

SECTION II

Problems of Supply and Demand 8

SECTION III

Evaluation of Present Sources 15

SECTION IV

Evaluation of New Sources 20
Energy Facts and Analogies 23

SECTION V

Providing for the Future 25

KIT INVENTORY FOR THE ENERGY CHALLENGE 28

ANSWERS TO THE UNIT TEST 28

UNIT SCHEDULE SHEET FOR THE ENERGY CHALLENGE Inside Back Cover

INTRODUCTION TO THE UNIT
THE ENERGY CHALLENGE

Students will be confronted in this unit by the fact that we consume more energy per capita in the United States to pursue our cultural, industrial, and economic lives than citizens in any other country in the world. Students will discover that the United States, with approximately 7 percent of the world's population, annually uses over 35 percent of the total energy produced in the world.

An *energy crisis* concept is presented for students in the Preface to the **Student Resource Booklet**, which tells them that "as Americans. . .we are at a turning point which we have called the **energy crisis.**" Identification is also given to the students of these major areas wherein good decision-making must take place—and soon:

- **We have to know if we can change the connections that exist between our styles of daily life and our growing demands for more energy.** Will we freely choose smaller cars and mass transit, building designs that economize heat and light, and—if it is costly—recycling of all possible resources?

- **We have to know if the United States can continue to be the biggest energy consumer on the international scene.** Are we and developing nations around the world going to be in real competition to get and use the world's energy resources?

- **We have to know if our environment will be spoiled as we supply more and more energy to our population.** Will we, or our descendants, have to live with air and water pollution and with radioactive wastes in order to satisfy the energy demand?

- **And, finally, we have to know if each energy resource that we are now using can be more or less helpful to us in the future.** Which old and which new resources can we safely develop, and how much of a job can each one do for us?

As the unit evolves, you can expect your students not only to acquire energy facts but also to express an interest in the human attitudes and values associated with the facts.

The Guide provides you with methods and suggestions that will help you coordinate the components of this unit into a meaningful sequence of events for your class. The unit is composed of five sections; under the heading **Making the Materials Work, Suggestions for the Teacher**, you will observe that we have presented a treatment of the components to be used in a section in the same sequence that we suggest you use them. We recommend that you use the suggested sequence the first time you teach the unit and make any variations thereafter which you prefer.

We have field-tested *The Energy Challenge* and represent it as a two week instructional unit which can be used daily for about ten hours. However, it is flexible enough for you to make whatever adaptations best suit your local class scheduling. Please note that suggested extension activities (Activity Cards 1 – 12) are identified and described at the end of each section for which the extensions are appropriate activities.

Section I	**The Energy Consumer** defines *energy* and *consumption* and specifies the ways in which energy can be measured; in this section students analyze the frames of a silent filmstrip in order to comprehend the meanings of **work, power, and fuel.**
Section II	**Problems of Supply and Demand** introduces students to the patterns of energy use in the United States and encourages serious consideration of the inefficiency of electric power production and transmission.
Section III	**Evaluation of Present Sources** (hydroelectric, coal, natural gas, and oil) precedes a critical appraisal of the United States' dependence on foreign oil and a study of the controversial nuclear power issue.
Section IV	**Evaluation of New Sources** (fusion, geothermal, wind, wastes, and solar) is made through booklet articles and the second filmstrip, as students prepare for the role-playing activity of the next section.
Section V	**Providing for the Future** is done through a mock **Congressional Hearing** at which students participate as energy "experts" and as members of a Congressional Committee on Energy Needs to determine the best ways to meet short-term and long-term energy needs in the United States.

INSTRUCTIONAL OBJECTIVES

The developers of *Priority One: Environment* have recognized student input as essential to structuring significant learning experiences. The materials in this unit, *The Energy Challenge*, have been student and teacher-tested in the development stages. The educational objectives of the unit, as specified below, are correlated with a twenty-question multiple-choice test. It has been provided for your use on two of the Ecomasters. Answers to the test appear on page 28 of this Guide.

We recommend that you administer the unit test to each of your students before and after using this unit so that you can measure the growth in learning that the field-testing of each *Priority One* unit has shown to take place. Further inquiry concerning evaluation procedures and designs can be made directly to the **Pollution Control Education Center, Union Township Board of Education, Union, New Jersey.**

At the end of this unit, the student will be able to:

1. State one way in which foods and fuels are similar, and one way in which foods and fuels are different.

2. List the energy sources that are used in the United States each day and specify how much of the total demand each supplies.

3. Identify the major categories in which energy is used in the United States today.

4. Estimate his own energy consumption for a typical day.

5. Give two reasons for the increasing consumption of energy in the United States.

6. Build a model generator and/or explain how an electric generator produces electricity.

7. Give at least two examples of how energy is lost when it is converted from one form into another.

8. Name three ways that energy can be conserved in transportation.

9. Name two ways that energy can be conserved in industry.

10. Explain why fluorescent lighting is more efficient than incandescent lighting.

11. Explain how the roof of a house can save energy.

12. Calculate which cars consume the least amount of gasoline.

13. Give two reasons why coal supplied 70 percent of the energy demand of the United States in 1900 and only 18 percent in 1975.

14. Give two reasons why the United States has been dependent on foreign oil.

15. Describe how a nuclear reactor can produce electricity.

16. Name one advantage and one disadvantage to developing the nuclear option.

17. List and evaluate at least three new sources of energy in terms of environmental impact, technology, potential supply, and costs.

18. Evaluate the energy potential of a wind-powered generator in a specific region.

19. Describe how geothermal energy can be tapped.

20. Explain how the use of fuel cells could increase the efficiency of transmitting electricity.

SECTION I THE ENERGY CONSUMER

FOCUS

In this section the students will learn how important energy is to them as living organisms and as members of our society. They will discover that energy consumption is not only necessary in order for them to remain alive, but also in order to make their lives more meaningful and enjoyable. You might encourage your students to read the **Preface to the Unit** for motivational purposes a day or two before you begin your presentation.

The first article in the **Student Resource Booklet** points out to the student that he requires energy to fuel his body's sixty trillion cells every day of his life. Worksheet 1 then involves him in analysis of his own routine daily activities, analysis that will demonstrate to him that he consumes much more energy than is required to meet his basic food needs. Filmstrip 1, Part A and Worksheet 2 illustrate how the normal and routine tasks of human society account for the tremendous amount of energy which we take from the environment. Most students are astounded to find out that the average American's daily energy demand, considering how energy serves him in the home, in transportation, in industry, and in commerce, is about 230,000 kilocalories. Students also learn an *energy vocabulary* in this introductory section of the unit and trace some common *energy conversions.*

THE MATERIALS PROVIDED

Student Booklet	Audio-Visual Materials	Ecomaster Activities	Extension Activities
Preface to the Unit **Foods, Fuels and You**	**Filmstrip 1, Part A** (Silent Filmstrip)	**Worksheet 1** Are You a Big Energy Consumer? **Worksheet 2** Energy in Action	**Activity Card 1** How Electric is Your Home?

MAKING THE MATERIALS WORK, SUGGESTIONS FOR THE TEACHER

Booklet Article – Foods, Fuels, and You

As the students read this article, it will explain to them that both foods and fuels are potential forms of energy. It further identifies how energy is released, in what forms it can be released, and how much can be released. The term *oxidation* is presented and explained. The quantity of heat energy that is released from a substance, the students should know, is measured in calories. They should also know that one calorie is the amount of energy–from any source–that is needed to raise the temperature of one gram of water one degree on the centigrade scale. Be sure they understand too that a kilocalorie, also referred to as a Calorie, is a commonly used energy term; it signifies one thousand calories. Explain also that another common energy term has been derived from the British system of defining energy values. In this system, heat energy is measured in B.T.U.'s, or British thermal units. A B.T.U. is the amount of energy that is needed–from any source–to raise the temperature of a pound of water one degree on the Fahrenheit scale.

To ensure comprehension of the points made in the article, you can ask questions such as these:

1. What is *oxidation*?
2. What is *respiration*?
3. How are they different?
4. How are they similar?
5. What is the source of the energy flow on our planet?
6. What is the definition of a *consumer*?

Worksheet 1 — Are You a Big Energy Consumer?

Before distributing copies of the first worksheet, encourage your students to identify and describe as many forms and sources of energy as they can. As an oral listing evolves, write these categories on the chalkboard, and ask the students to cluster the items they think of under these headings: ELECTRICAL, THERMAL, MECHANICAL, LIGHT, CHEMICAL, and NUCLEAR.

After all responses have been ordered under the appropriate categories, you have an ideal situation for explaining that in most cases energy can be converted from one form into another. For instance, some materials glow when electric current is passed through them. Thus, electrical energy can be converted into light energy. If you wish, at this point in the discussion you can draw an arrow on the chalkboard from ELECTRICAL to LIGHT. Solar cells generate electricity when light strikes them, as you next can point out; another arrow, therefore, can be drawn from LIGHT back to ELECTRICAL. Explain that many substances radiate heat when electricity is passed through them. Then, you can draw an arrow from ELECTRICAL to THERMAL. If you mention that devices such as thermopiles produce electricity when heated, you can draw another arrow from THERMAL back to ELECTRICAL. Continue in like manner with examples given by members of the class, and make as many interconnections among the six categories as you feel will establish the fact that forms of energy are capable of conversion. **(Note: Information on conversion efficiency and on the problems of waste heat will come later in the unit.)**

Hand out Worksheet 1. After the students have read the directions and the example, have them fill in the chart in class or for homework. Under the heading "Type of Energy," the students can indicate either the form in which the energy is purchased or one of the six categories that you have just identified in class. For example, chemical energy in gasoline is converted into heat energy in the cylinders of an automobile engine and then converted into mechanical energy by the pistons. If the student indicates an energy use such as riding in a car, either *gasoline* or *chemical energy* should appear in the column "Type of Energy." Clarify the use of this worksheet for your students by stating whether they should indicate form of purchase or type of energy in this column.

You may wish to explain to the students concerning the column "Amount of Energy Used" that energy is not ever used up, in the sense that it disappears from the universe, but that using energy can convert it into a form from which no additional work is available. For example, someone may bake a cake in an oven. The heat energy that causes the cake to bake is also dispersing and dissipating throughout the rest of the room and the house. It is a situation such as this in which energy is considered used, since in no practical way can it be collected, recovered, converted, or reused.

After completing the charts, have the students answer the first follow-up question at the bottom of the page. Discuss the word *need*; it is very important. After this discussion, encourage the class to give the second question serious thought. Do many students want to redefine their needs?

Filmstrip 1, Part A (Silent Filmstrip) and Worksheet 2 – Energy in Action Instruct the students to be as observant as possible during the showing (and possible re-showing) of the filmstrip. Distribute copies of the second worksheet either before you show the silent filmstrip, if you want to prime the students for the specifics to look for, or wait until after the first showing, if you prefer.

The nine items on Worksheet 2 structure an appraisal of the filmstrip, and more. Questions 8 and 9, for example, seed-in important energy considerations that will be further elaborated in the unit. Other considerations are as follows: Question 1 leads the students to realize that energy is what causes *work* to be done. Question 2 elicits opinions, and can serve to reinforce the *needs* discussion from Worksheet 1. Question 3 causes the students to name energy sources; you might want to encourage them to identify energy in economic terms, to state the forms in which it can be purchased. Question 4 indicates that the consumption of energy does not always result in work.

When you are satisfied that the first four questions have produced adequate response, instruct the class to answer Questions 5 and 6. Do they really understand the differences and the similarities between foods and fuels? For Question 7, many students may not know that as growing adolescents, they require from 2,500 to 3,000 calories daily. It may be interesting to them to contrast the number of food calories they consume to the average American's daily total energy demand of 230,000 C.

(Note: For a more effective beginning of Section II, assign Worksheet 3, **The "Jeneration Jolt"** before concluding this section.)

Activity Card 1 – How Electric is Your Home?

The students have probably heard comments at home concerning the increasing costs of energy to the consumer. This activity begins by telling the student that twenty-five percent of all the energy annually used in the United States is for conversion into electric power. It then directs him to check both his family's electric bill and the number of major and minor appliances in his home. If several students elect to do this activity together, they will find it interesting to compare their kilowatt hour-computations with each other. They will also discover that by far the two greatest uses of electricity in the home are for heating and cooling.

SECTION II PROBLEMS OF SUPPLY AND DEMAND

FOCUS

The materials provided for this section of the unit will clarify for your students how and why the demand for energy has been steadily increasing in the United States. Students will be led to conclude that the increasing demand has been due to population growth, to people's desire for convenience, and to the inefficient—even wasteful—consumption of the energy sources being tapped now.

Worksheet 3, **The "Jeneration Jolt"** and the overhead transparencies entitled **How Energy Use Has Changed** and **Energy Use Grows in the U. S.** should be used to introduce this section of the unit. The booklet article **Blackout in the City!** will expose the students to a possible effect of our increasing demands, a blackout. Worksheet 4 will encourage them to discuss the prevention of real blackouts in their own communities. Worksheet 5 structures an activity on how electricity is generated. It also identifies some variables that can affect how much electricity is produced by a generator.

The section ends with an article and a worksheet on efficiency and a critical evaluation of the tendency in this country to go "all electric." Activity Cards 2 through 8 are appropriate extension activities for this section. Encourage your students to make use of these cards as enrichment activities for individualized instruction, group work, or whole-class use.

THE MATERIALS PROVIDED

Student Booklet	Audio-Visual Materials	Ecomaster Activities	Extension Activities
Blackout in the City!	**Overhead Transparency** How Energy Use Has Changed	**Worksheet 3** The "Jeneration Jolt"	**Activity Card 2** Appliances: Making a Wise Choice
Conservation and Efficiency	**Overhead Transparency** Energy Use Grows in the U. S.	**Worksheet 4** Blackout in the City! Can You Help?	**Activity Card 3** Which Cars Use More Gasoline?
	Overhead Transparency Loss of Energy by Conversion	**Worksheet 5** Building a Generator	**Activity Card 4** Incandescent vs. Fluorescent Lighting
		Worksheet 6 The Switch to Electric Power	**Activity Card 5** Can the Roof of a House Save Energy?
			Activity Card 6 Survey Your Home Insulation
			Activity Card 7 Testing for Good Insulators
			Activity Card 8 Designing a Turbine for Efficiency

MAKING THE MATERIALS WORK, SUGGESTIONS FOR THE TEACHER

Worksheet 3 – The "Jeneration Jolt"

Ask the students to take out Worksheet 3 and their answers to the questions on the worksheet.

Question 1 identifies their generation as the largest energy users yet. Question 2 describes changing life styles in America, concomitant with the increase in energy consumption. Be ready for all kinds of answers to Question 3. The more answers you get, the more the projected energy demands on the graph will be substantiated. Question 4 projects population growth as a key factor in the growing energy demands of the future.

When you get to Question 5, ask the students to explain their answers. You might wish to start a discussion by asking "Is it fair that we use so much energy?" Ask the students to imagine how people in other countries look at America's energy use. If a student answers, "Yes, it is fair because our country was blessed with many natural resources," ask whether that same logic would apply to the Arabs and their wealth of petroleum.

Much of the energy used in this country goes toward the comforts and life-styles of its citizens. Much energy is consumed in the manufacture of goods and products. Ask the students to describe how people in other countries benefit from American goods and products. **Discuss:** Do we supply them with things which their own countries could not? **Discuss:** Does this justify, in part, our tremendous energy consumption?

Overhead Transparencies – How Energy Use Has Changed—and—Energy Use Grows in the U. S. For the first visual, **How Energy Use Has Changed**, be sure the students understand the focus of the chart. Point out that population increase has already been mentioned as a reason for increased energy demands. This chart presents consumption as it relates to a generation on a per person basis. Can the students give their own reasons to explain the increases that are shown on this graph? They should be able to zero in on increased technology, changes in life styles, and increased creature comforts as largely responsible.

As you show the second visual, **Energy Use Grows in the U. S.**, be sure the students understand that 10^5 means 100,000 (a 1 with 5 zeros after it) and B.T.U. means British Thermal Unit, specifically the amount of energy needed to raise the temperature of one pound of water one degree on the Fahrenheit scale.

When the points have been made that Americans are demanding ever larger amounts of energy and that electrical energy will probably constitute a great measure of those demands, the students are ready to determine how those demands are being met and whether they will continue to be met.

Booklet Article and Worksheet 4 – Blackout in the City! Can You Help?

Suggest to the students that they imagine their city or town to be facing a blackout situation. Say that the newspaper articles on page 4 of their booklets have come from the local newspaper. Have the students read the articles to themselves.

One of the newspaper articles refers to a special mayor's committee that has been set-up. As you discuss that article, hand out Worksheet 4. The students are to role-play memberships on that committee and provide their own solutions to the problems presented by this particular blackout. When the class has completed Worksheet 4, summarize their solutions on the chalkboard and have them answer the questions under the charts. They should come to the realization that blackout prevention is the wisest, although often the most difficult, path to pursue.

The worksheet concludes with questions designed to aid the students in an investigation of their own community. These questions will require research. It is suggested, for example, that one or two interested students contact the electric company which serves your city or area. The students should be given a day or two to complete their assignments before reporting their findings to the class. Questions 1 through 5 then may be answered from the student's report.

With the threat of blackouts or brownouts (voltage reductions) looming over our cities and towns, one might wonder why there is such an increasing trend toward electrical energy as our major energy form. Explain to the students that some reasons for the increasing popularity of electricity might be these:

1. The country is already "wired" for it.
2. All forms of energy can easily be converted into electrical energy. It therefore becomes the common denominator of the energy world.
3. Electric motors can be small and quiet, but powerful.
4. Many chemical and metal refining industries require electrical energy, since no other form at present can meet their needs.
5. Electricity is easily converted into light and heat.

The reasons above, however, must also be viewed in light of the following drawbacks:

1. Electrical energy cannot be stored in quantity.
2. Electrical energy does not occur naturally in large amounts. All electricity used by man must be generated. None is collected and used *as is*.

The first drawback will be overcome in part by the development of battery technology and by the research and development of a hydrogen economy which will be discussed in Section IV. The second drawback has been minimized by our capacity to generate electricity on a large scale. Since electricity will play a greater role in our lives, it is important that these students investigate the generation of electrical energy as it too will become more and more important to them.

Worksheet 5 — Building a Generator

In order for the students to understand the principle behind the generation of electrical energy, it is suggested that you use Worksheet 5 at this point. If possible, the experiment described on Worksheet 5 should be conducted by the entire class. If

you cannot get enough equipment, it could be conducted by the teacher or by a few students as a demonstration.

When either the magnet or the wire coil are moved, the galvanometer needle will be deflected, indicating that an electric current has been produced. The six steps of the procedure allow the students to discover this and also to discover that, when the speed of the magnet, the strength of the magnet, or the number of coils is increased, there is a corresponding increase in the amount of needle deflection and, therefore, in the amount of electricity being produced.

When the students have collected their data, have them answer the questions on the worksheet. Question 1 asks the students to summarize the results of their investigation. Question 2 reminds the students that they did not create energy. They simply changed its form (refer to energy conversion diagram in their notes from Section I). Question 3 allows the students to see their technique applied on a large scale. Indicate to them that by turning the coil in a circle, rather than back and forth, they can produce a continuous flow of electricity. Question 4 may require you to answer it, should the students be unable to.

Worksheet 6 -- The Switch to Electric Power

The efficiency of an operation is determined by comparing the results of the operation against the energy used to achieve the results. Worksheet 6 is an exercise in which the students are asked to determine the efficiency of electrical energy when it is used to heat water and to determine the efficiency of another form of energy (the combustion of natural gas) when it performs the same operation. Students then compare the efficiencies of these two forms of energy.

The question at this point is, "Is electricity our best bet?" When an electrical generator converts some form of energy to electrical energy, is the conversion complete or is energy wasted? When we convert electrical energy into another form, is the conversion complete or is there waste here too?

Explain to the students that this transformation of mechanical energy into electrical energy brings up a problem which occurs whenever one type of energy is converted to another type. The problem is that we cannot get all of one form of energy to convert into the desired other form. There is waste which in most cases can be minimized, but not eliminated. For example, incandescent lights, many electronic devices, and electric motors give off heat while in operation. This heat represents waste caused by the process of conversion.

Additional energy is lost during delivery. Also, inefficient insulators, storm damage, bad splices, short circuits, and transformer heating all take their toll and rob us of some of the electrical energy that is on its way to our homes.

Hand out Worksheet 6 and discuss the questions on it with your students. Questions 1 and 2 require examination of the illustrations on the worksheet. Question 3 is important because it points out where energy is lost in each step or stage during conversion. Question 4 points out that the all-electric home wastes much energy. Question 5 is an opinion question. Most power plants effectively control pollution, but do not re-use waste heat. Question 6 is another opinion question incorporating data from the worksheet with the students' knowledge of current technology.

Overhead Transparency – Loss of Energy by Conversion Be sure the students understand that much of the waste problem concerning all-electric homes (Question 4) is in the efficiency of the power plants (Question 3). Therefore, a study of power plant efficiency is in order. A modern fossil fuel electrical generating plant, for example, often loses 60 percent of the chemical energy that is released from the fuel.

Cover the bottom of the transparency and have the students compare the amount of chemical energy in the coal with the amount of heat energy in the steam. Show them how to compute the efficiency of the conversion by using the formula:

$$\frac{\text{energy out}}{\text{energy in}} \quad X \quad 100 = \text{efficiency}$$

Uncover that part of the overhead which shows that the conversion of chemical energy to heat energy is 88 percent. This is the efficiency of the boiler. Explain that 22 percent of the chemical energy is lost as heat through smoke stack (not shown) and lost as heat which radiates from the walls of the boiler.

Using the same formula, have the students compute the efficiency of the turbine to one decimal place and round it off. When they have completed this, uncover the part of the overhead which shows that the turbine is 47 percent efficient. Ask the students to guess where the rest of energy escapes. For example: "Are the walls of the turbine or the coils underneath warm?" "Why?" Have the students compute the efficiency of the generator to one decimal and round it off. When they are finished completely, uncover the overhead transparency. Ask if the walls of the turbine will be as warm as the walls of the generator and why. Finally, the students may compute the total efficiency of the plant.

Booklet Article – Conservation and Efficiency

Have the students read Booklet Article 3, Conservation and Efficiency. To determine student understanding, ask questions such as:

> ***How much energy is lost in an open fireplace? How much energy is lost in a well designed home furnace? How much energy is lost in the average fossil fuel electric power plant? How much might this figure be changed? What is a total energy plant? What is its efficiency? How does recycling metal and paper increase efficiency and therefore conserve energy?***

Activity Card 2 – Appliances: Making a Wise Choice

> After the class has finished Worksheet 2, The "Jeneration Jolt," they will realize that their generation consumes much energy. "Since we require so much energy, are we doing our best to conserve it?" "Do we waste it because it seems so plentiful?" are some questions which might come up. This activity card, if used after Worksheet 2, will help the students to realize that some appliances such as air conditioners can be designed to use energy conservatively or to waste it. It is their responsibility to determine the difference and buy accordingly.

Activity Card 3 – Which Cars Use More Gasoline?

The Booklet Article entitled **Conservation and Efficiency** recommends possible ways we can make our limited energy sources last longer. One suggestion is that we use smaller cars with fewer electrical gimmicks and keep those cars running properly.

Activity Card 4 – Incandescent vs. Fluorescent Lighting

This activity is simple and graphic. The incandescent light bulbs will use more electricity to generate heat than the fluorescent bulb. The waste heat represents an undesirable form of energy conversion and is inefficient. It is suggested that the students use white outdoor type decorative lights and space them equally over a distance a little less than the length of the fluorescent light bulb. Each small outdoor light bulb has a wattage of 10. Read the wattage of the fluorescent bulb and divide by 10 to determine the number of small incandescent bulbs to be used. The use of one large incandescent bulb equal in wattage to the fluorescent bulb would cause the light and heat coming from it to be more concentrated and, therefore, drive the temperature of the water much higher than it should be. (Fluorescent bulbs produce 80 lumens of light for each watt of consumed power; incandescent bulbs produce 20.)

Activity Card 5 – Can the Roof of a House Save Energy?

The roof of a house can do more than keep the rain out of the attic. It can save fuel used for heating in the winter and save electricity used for cooling in the summer. These sayings can be achieved by proper choice of roof color, as this activity card demonstrates. If you cannot obtain measuring cups, use aluminum soda cans. The containers must be of aluminum, the thermometers must be located in the center of the container, and all openings must be sealed in order to keep the heated air within from escaping. You can use masking tape as a sealer.

Activity Card 6 – Survey Your Home Insulation

A potential savings of 15 to 30 percent on home heating fuel bills should encourage students to survey their home insulation as outlined on this card. Point out to the students that attic insulation should have a rating of R-19 (while ceiling and floor insulation should have a rating of R-11 or R-13). This higher rating is an indication that the attic and roof of a home are important sites of heat loss. (Refer to Activity Card 5)

Activity Card 7 – Testing for Good Insulators

Home insulation can be an important energy saver. But which type of insulator is best? This card allows the students to determine the relative qualities of commonly used home insulation materials. You might wish to explain to the students that air is a very good insulator. Usually, the more air an insulating material can trap, the better it is at insulating. (Refer to Activity Card 6)

Activity Card 8 – Designing a Turbine for Efficiency

Power companies can save energy by generating it as efficiently as they can. The most common type of electrical generator is the steam-turbine type. This activity card allows the students to construct their own steam turbines and experience the same efficiency problems that plagued the engineers who eventually perfected the first turbines. Tell students who elect this activity to be sure a cork or rubber stopper is used in the mouth of the can, not the original screw cap. The stopper will act as a safety valve.

SECTION III EVALUATION OF PRESENT SOURCES

FOCUS

This section begins with a filmstrip entitled **Sources of Energy, Part B**. The filmstrip recaps Sections I and II, introduces Section III, and raises some questions which will be discussed in Sections IV and V.

Also included are three booklet articles designed to enable the students to

1. learn about our present sources of energy by differentiating between factual and opinionated materials,
2. identify political and economic factors concerning the oil crisis, and
3. learn how nuclear energy can be converted into electrical energy, and to consider the pros and cons of nuclear power.

THE MATERIALS PROVIDED

Student Booklet	Audio-Visual Materials	Ecomaster Activities	Extension Activities
Our Present Sources	Filmstrip 1, Part B Sources of Energy		Activity Card 9 Getting All the Oil Out
The Oil Crisis	Audio Cassette, Side A		
The Nuclear Controversy	Overhead Transparency How Does a Nuclear Reactor Work?		

MAKING THE MATERIALS WORK, SUGGESTIONS FOR THE TEACHER

Filmstrip – Sources of Energy, Part B Introduce Section III by showing the filmstrip **Sources of Energy, Part B**. This part of the filmstrip begins by identifying the sun as the source of all energy on our planet, and then it provides information concerning the fossil fuels, how they were formed, and how important they are as energy sources today. The visual encourages students to realize that we have been expending our reserves of oil and natural gas at a very fast rate, despite the fact that these fuels can not be restored by nature. (On page 7 of the **Student Booklet, The 1973 Energy Pie** will point out to them that 94½ percent of all the energy sources consumed during that year came from oil, natural gas, and coal.) As the filmstrip identifies and describes the sources of energy that we are currently using, students should begin to evaluate the sources on the basis of these criteria: environmental impact, existing and developing technology, extent of supply, and costs.

Booklet Article – Our Present Sources

The booklet article **Our Present Sources** starts with a brief introduction and a chart. Have the students read the first paragraph of the article on page 7 and examine the chart carefully. When they are finished, you might want the students to review the filmstrip information by stating how all the sources mentioned, except nuclear, come indirectly from the sun's energy (oil, natural gas, coal, and wood from photosynthesis and hydroelectric from the evaporation, condensation, and subsequent run-off of water).

Much information has been and is being disseminated about our present and future energy supplies and sources. Because the information is often incomplete or biased, the students should learn to be able to determine the validity of such reports. Therefore, the information that is presented in the **Student Booklet** for each of our present sources except wood–hydroelectricity, coal, natural gas, and oil–is introduced by a typical, believable opinion concerning the source. Then the opinion is followed by objective data about the source.

Have the students finish reading page 7 and then tackle the purposely opinionated statement concerning hydroelectricity. When they have finished, have them answer the questions, "What point of view is presented?" "Whose view is it?" "Is it based on enough fact?" The answer to the last question will require the students to read the material entitled **Hydroelectric Power – The Facts**. Have them read this material and then answer, "Is it based on enough fact?" If the class does not agree, you may wish to allow those who say yes to discuss the matter with those who say no. If they feel the facts do not support the opinion, you can encourage them to try to determine why the writer of the opinion has distorted or ignored the facts.

Try using this procedure to evaluate the remaining articles. Have the students read the opinions, answer the first two questions, read the facts, and answer the third question. Once the students have read each set of facts, refer them again to the chart on page 7 and ask them how they think the *Energy Pie* of the future will look. If you wish to extend this activity, you can use actual public statements made by responsible spokesmen. Have the students bring in newspaper and magazine articles containing viewpoints about our energy sources. Before beginning Section V, distribute the articles. Have the students read and share them to evaluate the various viewpoints. This activity will be helpful in providing up-to-date information for use in the **Congressional Hearing** activity of Section V.

Booklet Article – The Oil Crisis

The oil crisis of 1973-1974 may go into the history books as the single episode that woke up Americans to the fact that our life-styles cannot continue unchanged forever. We abruptly confronted the reality that we can not continue to expect to get and use so much of the world's oil. We Americans have, as a result, become more energy-conscious today than we have been since World War II.

The booklet article **The Oil Crisis** provides information for the students that will enable them to understand why the oil issue poses America's most problematical and most urgent energy questions. Have the students read the article, share their answers to the four questions on page 17, and discuss their answers if any disagreement occurs.

Booklet Article – The Nuclear Controversy–and–Overhead Transparency – How Does a Nuclear Reactor Work?

As pointed out in Section II, our demands for electrical energy have been skyrocketing. Many power-generating plants use oil and other fossil fuels to fire their boilers. The search for alternate sources of fuel to generate electricity has encouraged many people to explore the nuclear option.

Electric power companies became interested in nuclear power as soon as the achievement of nuclear fission became known to the public in 1945. Since then a controversy has arisen as to whether it is truly a good, safe source of energy.

It is suggested that you show the overhead transparency **Energy Use Grows in the U. S.** again. Explain to the students that due to contingencies such as the oil crisis and to the increasing amounts of energy that we consume for transportation, our domestic oil supplies may at any time have to be shifted from the production of electricity to fuel our automobiles, buses, trucks, and airplanes. Because of this, an alternate source or alternate sources for the production of electrical energy must be found. Mention to the students that, in the short run, there appear to be two alternatives, coal and nuclear energy. The return of coal into the energy race has already been discussed in the booklet article. A discussion of how nuclear energy may fare in the race will be covered in the booklet article **The Nuclear Controversy**.

Have the students open their booklets to **The Nuclear Controversy**. Let them examine the graph on page 18 and answer the questions orally or in their notebooks.

> Questions 1 through 4 give a hint as to the *Energy Pie* of the future. You might wish the students to compare this graph with their own *Energy Pie* predictions in Section II.
>
> Question 5 can not be answered by examining the graph. Explain to the students that because of the controversy no one really knows exactly how much the use of nuclear power will increase by 1985.
>
> Question 6 asks the students to consider whether the predictions on the graph are valid in the light of what they have learned about our present sources of energy.

The information in this article, too, is introduced by typical statements for and against the use of nuclear power. Have the students read them. Explain to the class that before they can react to either statement they must know the facts. Have them read **What is Nuclear Power Today?**, **Fission**, and **The Boiling-Water Nuclear Reactor**. When they are finished, show the overhead transparency entitled **How Does a Nuclear Reactor Work?** To determine whether the students understand what they have read as they appraise the visual, ask them the following questions:

1. Where does the heat energy come from?
2. How is heat released from uranium?
3. What are control rods?

4. How do they control the reaction?

5. Can you trace a molecule of water through the diagram of the nuclear reactor and explain what happens to it?

6. Which part of the diagram shows where the electricity comes from?

Next have the students read **Our Nuclear Past** and **The Atomic Energy Act**. You may wish to point out that in October, 1974, the Atomic Energy Commission was disbanded. The President signed a bill which dissolved the United States Atomic Energy Commission and turned its functions over to two newly formed agencies, the Energy Research and Development Agency (ERDA) and the Nuclear Regulatory Commission (NRC). The NRC is responsible for the safety and licensing of nuclear power plants and includes the regulatory machinery of the former AEC.

The Promise of Nuclear Power is an article which shows that the production of nuclear-based electricity on any large scale is at present still a promise. After twenty-five years and billions of dollars for research and development, nuclear power has only recently surpassed firewood in the sense of the total energy which it supplies annually to the United States (about 1½ percent in early 1975). In fact, it was after 1971 that the amount of electricity produced by all the nuclear power plants exceeded the amount of electricity consumed for the enrichment of the uranium which the plants used for fuel!

The students should now finish reading to page 23. When they have finished, have them read again the statements on page 19 and discuss each now that they know the facts. The main point you should make is, "Is nuclear electric power a worthwhile power source?" There are other alternate sources. They are being developed. Answers to questions like, "What are they?" "How do they work?" and "When will they be ready?" will be developed in Section IV.

Activity Card 9 – Getting All the Oil Out

Movies have made the oil "gusher" a very popular misconception. Although a few wells will react this way and require no pumping, most oil wells are such that the oil must be forced to the surface. Two of these secondary recovery methods can be duplicated by your students if they follow the instructions on this card.

At one point in the procedure, no fewer than four hands may be needed. It is therefore suggested that students who elect to do this activity, do so in pairs. Remind the students when they pour the oil down the straw in order to fill the jar to the desired level, to remember to take into consideration the oil in the straw so that they stop pouring a little before the oil in the jar has reached the desired level.

Note to the Teacher

The culminating activity of this unit is a mock **Congressional Hearing** at which the students assume roles as Congressmen and "energy experts." It is recommended that the students, especially the "energy experts," obtain as much additional contemporary information as they can regarding potential energy sources. Hand out Worksheet 7, **Congressional Hearing: The Energy Crisis**. Have the students read it, and then ask for volunteer "energy experts." Role playing can be a very effective teaching technique. Be sure that responsible students are assigned as "experts" and as members of the Congressional Committee on Energy Needs. Explain to the "experts" that, in Section IV the Committee and the rest of the House of Representatives (the rest of the class) will receive general background information by way of a filmstrip and booklet articles. It will be their job to evaluate and present this information, as well as any supplementary information which they obtain.

SECTION IV EVALUATION OF NEW SOURCES

FOCUS

After the students have learned that fossil fuels are not in infinite supply on our planet and that nuclear fission—due to environmental and technological factors—will not be a cure-all for our energy problems, it is appropriate for them to investigate other sources of immediate and potential supply. Since they have been primed by receipt of Worksheet 7, **Congressional Hearing: The Energy Crisis** at the conclusion of Section III, they should be alert throughout Section IV to the need for sifting and sorting out all the energy-information that they read, see, and hear. Student evaluations should be based on these four criteria: the environmental impact of each source, the existing and developing technology for each source, the potential supply of each, and the costs. Filmstrip 2, **Sources of Energy** serves as an overview of energy sources available to man in addition to those being exploited on a large scale today. These additional sources are also discussed in detail in the booklet articles entitled **Tapping New Sources** and **Developing Other Ways. Tapping New Sources** explains how various forms of energy, specifically nuclear fusion, geothermal, wind, waste conversion, and solar energy might be harnessed and made useful. **Developing Other Ways** discusses the theory and advantages of a hydrogen economy and the operation of various kinds of fuel cells.

THE MATERIALS PROVIDED

Student Booklet	Audio-Visual Materials	Ecomaster Activities	Extension Activities
Tapping New Sources	**Filmstrip 2** Sources of Energy		**Activity Card 10** Is Wind a Good Source of Energy in Your Area?
Developing Other Ways	**Audio Cassette, Side B**		**Activity Card 11** Tapping Geothermal Energy
			Activity Card 12 A Solar-powered Motor

MAKING THE MATERIALS WORK, SUGGESTIONS FOR THE TEACHER

Suggested Inquiry Activity to Introduce Section IV Divide the class into groups of four or five students. Allow the groups five to ten minutes to appoint a recorder for their group, who will list as many sources **not** already identified in **Our Present Sources** as his group can think of. At the end of the time limit, have one of the recorders list on the chalkboard the alternate sources suggested by his or her group. When that recorder is finished, have the other recorders in turn add any other sources that were suggested by their groups.

Next, evaluate the list compiled by the class and eliminate by class consensus those sources that most students feel would not be of significant help to counteract an energy crisis—such as lightning or hamsters running around in exercise wheels! Once the list has

been edited, encourage the class to re-group the sources they have suggested into one or more of the following categories:

1. Which sources might be used to run automobiles, trucks, and airplanes?

2. Which sources might be used to heat homes and factories?

3. Which sources might be converted into electricity?

In all probability, your students will discover during the course of this brainstorming that most of the sources could not easily be used to run automobiles, trucks, and airplanes. Explain, then, that conversion problems are a key reason for making wise use of the petroleum resources that we still have.

Tell your students that scientists in our country and in many other countries have been going through brainstorming sessions like this for many years in order to identify and then evaluate alternate energy sources, just as they have done in their own classroom. With the students' own effort to identify possible alternate sources still on the chalkboard, you should next show Filmstrip 2; it will name and briefly describe the most common alternate sources that have been suggested by contemporary scientists. After you show the filmstrip, the students will probably want to compare the list they made with information presented in the visual. Are there major differences to be accounted for? Can you or they account for the major differences?

Filmstrip 2 – Sources of Energy The filmstrip begins by positing a crucial question in the energy dilemma today, "What else can be used to produce steam for our power plants besides the burning of fossil fuels or the fission of uranium atoms?" The visual then defines geothermal energy and describes its potential. Next it states that much of what we regard as "garbage" is recyclable by conversion into various kinds of fuels. These fuels, processed from waste materials, can be used to heat homes, run factories, and generate electricity. Ways for channeling solar energy and nuclear fusion into the production of steam-fired electricity are also specified.

"But who says we must have steam?" the visual asks next. Answers can also be found, the students learn, in exploration of the potentials of wind, magneto-hydrodynamics—or MHD, as it is more often called—solar cells, and fuel cells. The filmstrip concludes by saying, "Some of these new sources are closer to reality than others. The remaining articles in your **Resource Booklet** will give you more information about them, and you can evaluate them yourself on practical, economic, and environmental terms."

Booklet Articles – Tapping New Sources—and—Developing Other Ways

The treatment of each source presented in the **Student Resource Booklet** (except MHD, which is not detailed further in the booklet than in the second filmstrip) is intended to be brief but comprehensive. The students should read and evaluate each source with the already-mentioned four criteria in mind: environmental impact, technology, extent of supply, and costs to the consumer. They should also continue to be alert for reports in the media concerning breakthroughs in research or changes in federal options to fund the development of particular sources.

You should feel comfortable in reminding your students often that all energy-source evaluations that they make and all energy-decisions that they would like to see implemented in order to solve our present energy crisis should be tempered by awareness that as a society we must: (a) devise ways to counteract our present emergency situation and still (b) keep our own best long-range interests in mind. Supplemental information for the teacher—interesting, amusing, sometimes shocking facts and figures that you can intersperse in class discussions—are provided for you at the end of this Section.

Activity Card 10 — Is Wind a Good Source of Energy in Your Area?

In some areas, wind-powered electrical generators may be feasible for supplementing conventional power-generating stations. They can and do, for example, supply cost-free electricity to persons living in remote regions. This card will encourage the student to determine whether his immediate locale—or one that he would like to visit and monitor—would be appropriate for setting up a windmill. Mention to any student who elects to perform this activity that local weather stations may supply helpful information.

Activity Card 11 — Tapping Geothermal Energy

Tapping heat from within the Earth is an exciting thought. The activity outlined on this card is a graphic demonstration of the principles by which geothermal energy can be harnessed. One caution, however: driving the glass tubes through the stoppers can be a tricky operation. It is suggested that the tubes be lubricated with glycerin and that this feat be accomplished by (or assisted by) one who is aware of the need for caution.

Activity Card 12 — A Solar-powered Motor

Solar power is now providing energy for most of our man-made satellites and space probes. As an energy source it is much-heralded for its potential to heat homes and to generate electricity. This activity outlines for students a procedure whereby light energy can be converted into electrical energy. It also demonstrates the inverse square law as applicable to light waves; i.e., that as a light source moves away, its illumination diminishes at a ratio of the distance squared. A student who elects to do this activity might like to record the number of sunny days in an area during one month, and then determine the extent to which solar power could practically supply or supplement electricity there.

ENERGY FACTS AND ANALOGIES

Informative miscellany concerning both present and potential energy sources is categorized for your use below in alphabetical order.

DID YOU KNOW THAT . . . .

- your body right now is giving off one hundred watts of heat.

- the United States uses **TWICE** as much energy as all of Africa, the rest of North America, South America, and Continental Asia.

- the number of cars in the world today is estimated to double by the year 1985. The annual **operation** of automobiles in the world today consumes 6 percent of the world's energy.

- if per capita energy use in the United States were reduced to be equal to the per capita consumption of France, then everyone else in the world would have potentially one-fourth more energy at their disposal.

- 200 million Americans use more electricity for air conditioning than 800 million Chinese use for everything.

- most modern architecture is energy wasteful: high electric lighting levels, poor insulation, universal air conditioning, electric heating, excessive volume, and insufficient use of solar heat and light.

- more energy is consumed in the process of canning vegetables than the food value of the vegetables themselves.

ELECTRICAL ENERGY

Each mile of transmission lines requires 100 acres of land.

Each modern 1,000 megawatt power plant measures about 1,000 feet on each side. If our power needs continue to grow, in fewer than two centuries all the land space in the United States could be taken up by such plants.

A ton of steel, processed from ore, consumes 2,700 kilowatt-hours of energy, while steel that is reclaimed and reprocessed in an electric furnace requires only 700 kilowatt-hours per ton.

A ton of aluminum, extruded from ore, requires 17,000 kilowatt-hours.

For each unit of heat put into a house through electric space heating, two units of waste heat go into the environment at the site of the power plant.

Electric industries estimate that they will need to use half of the annual energy production of the United States in the year 2,000. This could mean that two-thirds of the water runoff on our continent would be needed to absorb and cool the waste heat.

One automobile traveling at 50 mph consumes in one hour as much energy as 3,000,000 electric toothbrushes consume in one entire year.

FOSSIL ENERGY

In 70 to 80 years, it is estimated, the great bulk of the world's supply of recoverable petroleum liquids and natural gas will be gone.

Recoverable liquid fuels from tar sands and oil shales could supplement conventional petroleum fuels and extend the total lifetime by 100 years.

Coal, if used as the principal energy source at expected increased demands, would last only two or three centuries.

Only 30 to 35 percent of the oil in an average reservoir is now recovered, compared to 80 percent for gas and surface-mined coal, and 55 percent for subsurface mined coal.

Natural gas provides one-third of United State's energy and is our sixth largest industry.

High grade oil shale (10 to 20 percent hydrocarbon by weight) is often under hundreds of feet of overburden which must first be removed.

Liquid Natural Gas (LNG) is transported by special tankers, each carrying 125,000 cubic meters. If such a tanker collided with another vessel or encountered a hard grounding, a cloud of asphyxiating gas could extend 5,000 meters downwind in 20 minutes. If ignited, the gas would release heat-energy equivalent to 55 atomic bombs!

HYDROELECTRIC ENERGY

In theory, hydroelectric sources could be tapped to supply ten times the present total. In practicality, this will probably not happen because silt, accumulating behind the dams, could make some reservoirs useless. Also, land-use conflicts (on political, economic, and ecological issues) often delay or prevent hydroelectric development.

MUNICIPAL WASTES

Most municipal solid wastes can be processed to supply an energy value of 5,000 B.T.U.'s per pound, which is approximately one-third the energy value of coal.

NUCLEAR ENERGY

A 1,000 megawatt nuclear plant discharges about 2.5 million B.T.U.'s per second in the form of waste heat. This amount of waste heat could supply the heating needs of over 300,000 homes during the winter.

The amount of energy that can be derived from the amount of deuterium in 30 cubic kilometers of seawater is about equal to the Earth's initial energy supply of fossil fuels.

Plutonium 239 (used in fast breeder reactors) is very toxic. A dose lethal to everyone on Earth could fit in a container the size of an orange.

Some radioactive wastes from nuclear power will remain radioactive for 100 million years before they lose their potency.

Nuclear reactors can be fueled by Earth's supply of uranium only for the next 100 years before the supply runs out.

A few kilograms of uranium 233, plutonium 239, or enriched uranium 235 can be made into a crude but convincing nuclear weapon by a physicist, a small group of technicians, and a well-equipped shop in less than a year.

SOLAR ENERGY

The sun supplies about 1000 watts of energy to each square meter of Earth everyday.

Photothermal conversion requires less land than strip-mining of coal.

Use of solar energy could serve to decentralize a population (make it less urbanized) and increase its self-sufficiency.

Use of solar energy could serve to limit the amount of ecological mischief man could do in using or tapping other sources.

SECTION V PROVIDING FOR THE FUTURE

FOCUS

The final section of this unit provides your students with the opportunity to share the evaluations they have made of all the energy sources that are presently or potentially useful to citizens of the United States. Students should be encouraged to define their options carefully, with due consideration given to planning both for *short-term* and *long-term* needs. Role-playing as participants in a mock **Congressional Hearing** will involve the students in approving or rejecting a five-step program of **Tasks** ostensibly developed by the President of the United States and his advisors. Be sure the students understand that the five-step program, as outlined for you below, emphasizes ways to counteract a **crisis situation** and, as such, does not outline steps for meeting *long-term* needs.

Be sure that your students also understand that defining any sequence of **Tasks**, or energy priorities, must be an on-going activity, receptive to new information. At the time of this writing, for example, taxation on imported oil has just been increased, and one of several bills designed to limit the environmental harm of strip-mining has just been defeated in Congress.

Task 1. **Conserve** energy by reducing use, and conserve energy resources by increasing the efficiency of conversion processes.

Task 2. **Increase** this country's production of oil and natural gas as rapidly as possible.

Task 3. **Increase** the use of coal, first to add to and later to replace the use of oil and natural gas.

Task 4. **Expand** the production of nuclear energy as rapidly as possible, first to add to and later to replace fossil fuel energy.

Task 5. **Promote**, as much as possible, the use of renewable energy sources (hydro, geothermal, solar) and pursue the promise of fusion and central station solar power.

THE MATERIALS PROVIDED

Student Booklet	Audio-Visual Materials	Ecomaster Activities	Extension Activities
		Worksheet 7 Congressional Hearing: The Energy Crisis **Worksheet 8** Providing for the Future	

MAKING THE MATERIALS WORK, SUGGESTIONS FOR THE TEACHER

Worksheet 7 — Congressional Hearing: The Energy Crisis

In role-playing, a student can more fully formulate his own attitudes and ideas by gaining insight into the attitudes and ideas of other people. When casting the roles for Worksheet 7, you might find these suggestions helpful:

- **Speaker of the House** The teacher could be cast in this part. You, therefore, will be the one to call the session to order, instruct the Congress as to their objectives, control any discussions which occur, and maintain some semblance of parliamentary procedure.

- **Committee Members and Energy Experts** The teacher should see that care is taken in making suitable assignments in these roles. The roles are critical, and it is suggested that you select students you feel will be best suited to them.

- **Congressmen** Students who prefer to be on-lookers during the mock hearing can be the representatives. Instruct them to listen carefully, since they will be expected to vote at the end of the hearing.

In order to create an atmosphere for the hearing, you might want to try this seating arrangement. The members of the Congressional Committee should be seated in the front of the room with their desks turned to face the class. The energy "experts" should be seated in the rear of the room and called forward by the Speaker as they are needed. You may wish to invite another class to join yours, in order to add to the size of the audience.

In order to give the entire exercise more direction, it is suggested that each role-playing member of the class be briefed concerning his goals. His *vested interests* should be foremost in his mind as he plans his own proposals and when he votes. Some *vested interests* are identified below; these suggestions may stimulate other ideas.

ROLE	
Committee Member 1	Represents an oil producing state. Contributions from this industry put him into office. He does not want to raise corporate taxes.
Committee Member 2	Represents an industrial state. He endorses economic growth and the creation of jobs for his constituents. He also does not wish to raise income or sales taxes.
Committee Member 3	An environmentalist at heart. He represents a state with a large resort business and many parks.
Committee Member 4	Represents a state comprised largely of desolate desert-type terrain. He would like to see his state's population and economy grow.
Committee Member 5	Represents a state with large urban areas and large energy demands, but little available land. He is concerned about the high cost of energy and high income and sales taxes.

Some key points which the Energy Experts might want to make during their testimony are these:

- **Efficiency Experts (two)** Discuss voluntary versus mandatory conservation of energy. Explain how some large modern offices and factories are energy wasters. Stress the need for more mass transit and incentives to encourage car-pooling. These two experts should also support examination of methods to increase the efficiency of our technology, especially in electrical generating plants.

- **Oil Experts (two)** Emphasize the conservation of oil and gas resources. Describe how oil is used for products other than fuel. These two experts should delineate the extent of our present supplies and predict the long-term prospects for oil and gas. "Can America become totally independent of foreign oil before other countries use our dependence for blackmail?" should be their key question.

- **Coal Experts (two)** Stress the vastness of the United States' reserves. Acknowledge the ecological hazards of strip-mining, but affirm how these hazards can be avoided. Explain the differences between high-grade and low-grade coal, how air pollution has occurred, and how improved technology can eradicate air pollution problems. These two experts should also discuss the processing of our coal reserves into synthetic gas-like and oil-like fuels such as Hygas, Bygas, and Synthane.

- **Nuclear Experts (two)** Stress the availability of fuels for both fission and fusion reactors. Mention the potential hazards of transporting radioactive fuels and the problems of leakage or possible theft of fuels, but also emphasize that nuclear energy could potentially be inexpensive to the consumer, compared to other energy sources. Estimate when fusion reactors will be ready and how much their development would cost.

- **Solar Energy Expert (one)** Stress the cleanliness, availability, and efficiency of ALL solar-related energy sources. Provide additional information on various projects and methods being developed to harvest and use solar energy. This expert should also give cost estimates concerning large scale operations and give practical target dates for consumer use.

- **Geologist (one)** Explain in detail the techniques used to locate and tap geothermal energy. Explain the risk of causing earthquakes by pumping large amounts of water underground. Name locales where this energy is most feasible.

- **Meteorologist (one)** Explain some aspects of efficient windmill design and identify some areas where wind-generated electricity could be used to supplement or even replace conventional fossil fuel plants.

Allow each of the energy "experts" about three minutes to present their materials to the Committee. Then allow three minutes for questions from the Committee. When all the "experts" have testified, instruct the Committee either to approve the President's plan as

presented, or to build in amendments or revisions to the five-step program. The Committee should then present its decisions to the rest of the House for final acceptance or rejection.

Worksheet 8 – Providing for the Future

It may be convenient for the Committee members and other congressmen to have copies of Worksheet 8 in front of them to fill in as the "experts" testify. This worksheet would then serve as a guide to which the congressmen and Committee members can refer before they vote. Worksheet 8 can also be used as a homework assignment for each member of the class. In this way they will be able to *see* our energy future in terms of their own efforts and activities in this unit.

KIT INVENTORY FOR THE ENERGY CHALLENGE

1	Teacher's Guide
30	Student Resource Booklets
10	Ecomasters (8 Activities and the 2-page Unit Test)
4	Overhead Transparencies
12	Activity Cards
2	Filmstrips
1	Audio Cassette (recorded on Side A and Side B)

ANSWERS TO THE UNIT TEST

1. a	6. d	11. b	16. b
2. d	7. c	12. d	17. d
3. c	8. c	13. d	18. d
4. b	9. d	14. c	19. b
5. d	10. a	15. c	20. b

SECTIONS OF THE UNIT	STUDENT RESOURCE BOOKLET	COMPONENTS TO COORDINATE WITH RESOURCE BOOKLET		
		Audio-Visual Materials	Ecomaster Activities	Extension Activities
The Energy Consumer	**Preface to the Unit** **Foods, Fuels, and You**	**Filmstrip 1, Part A** (Silent Filmstrip)	**Worksheet 1** Are You a Big Energy Consumer? **Worksheet 2** Energy in Action	**Activity Card 1** How Electric Is Your Home?
Problems of Supply and and Demand	**Blackout in the City!** **Conservation and Efficiency**	**Overhead Transparency** How Energy Use Has Changed **Overhead Transparency** Energy Use Grows in the U. S. **Overhead Transparency** Loss of Energy by Conversion	**Worksheet 3** The "Jeneration Jolt" **Worksheet 4** Blackout in the City! Can You Help? **Worksheet 5** Building a Generator **Worksheet 6** The Switch to Electric Power	**Activity Card 2** Appliances: Making a Wise Choice **Activity Card 3** Which Cars Use More Gasoline? **Activity Card 4** Incandescent vs. Fluorescent Lighting **Activity Card 5** Can the Roof of a House Save Energy? **Activity Card 6** Survey Your Home Insulation **Activity Card 7** Testing for Good Insulators **Activity Card 8** Designing a Turbine for Efficiency
Evaluation of Present Sources	**Our Present Sources** **The Oil Crisis** **The Nuclear Controversy**	**Filmstrip 1, Part B** Sources of Energy **Audio Cassette, Side A** **Overhead Transparency** How Does a Nuclear Reactor Work?		**Activity Card 9** Getting All the Oil Out
Evaluation of New Sources	**Tapping New Sources** **Developing Other Ways**	**Filmstrip 2** Sources of Energy **Audio Cassette, Side B**		**Activity Card 10** Is Wind a Good Source of Energy in Your Area? **Activity Card 11** Tapping Geothermal Energy **Activity Card 12** A Solar-powered Motor
Providing for the Future			**Worksheet 7** Congressional Hearing: The Energy Crisis **Worksheet 8** Providing for the Future	